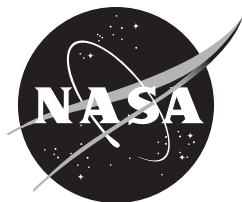
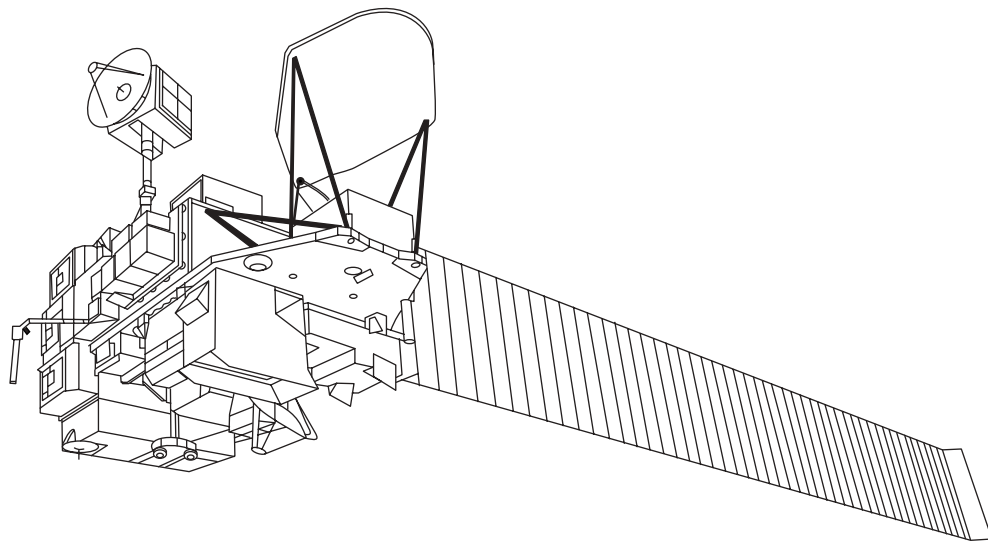


**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION**

# **SeaWinds on Adeos 2 Launch**

**Media Kit  
December 2002**





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## **RELEASE:**

### **NASA INSTRUMENT WILL CONTINUE THE WATCH ON OCEAN WINDS**

SeaWinds, NASA's latest Earth-monitoring instrument for measuring wind speed and direction over Earth's oceans, is set to launch aboard Japan's Advanced Earth Observing Satellite II (Adeos 2) at 8:31 p.m. Eastern Standard Time on December 13 from Japan's Tanegashima Space Center. The mission is expected to yield improvements in global weather forecasting and new insights into various Earth research investigations.

SeaWinds is set to replace an identical instrument already in orbit aboard NASA's Quick Scatterometer (QuikScat) satellite, which launched in June 1999. The instrument will augment a long-term ocean surface wind data series that began in 1996 with launch of the NASA Scatterometer aboard Japan's Adeos I spacecraft. Climatologists, meteorologists and oceanographers use these daily, detailed snapshots of ocean winds to understand and predict severe weather patterns and climate changes. The instrument is designed to operate three years, with a goal of five.

"Winds play a major role in every aspect of Earth's weather," said Dr. Ghassem Asrar, associate administrator of NASA's Office of Earth Science, Washington. "They directly affect the turbulent exchanges of heat, moisture and greenhouse gases between Earth's atmosphere and the ocean that drive ocean circulation and climate. The SeaWinds radar scatterometer will provide a critical tool for improving weather forecasting, detecting and monitoring severe marine storms, identifying subtle changes in the global climate and better understanding global weather abnormalities, such as El Nino and La Nina. NASA is pleased to partner with Japan on this important endeavor."

The mission will help Earth scientists determine the location, structure and strength of severe marine storms - hurricanes in the Atlantic, typhoons near Asia and mid-latitude cyclones worldwide - which are among the most destructive of all natural phenomena. The National Oceanic and Atmospheric Administration (NOAA), a chief mission partner, will use the data to improve weather forecasting and storm warnings, helping forecasters more accurately determine the paths and intensities of tropical storms and hurricanes.

"SeaWinds data will help meteorologists more accurately predict marine phenomena that affect human life," said Dr. Timothy Liu, project scientist at NASA's Jet Propulsion Laboratory, Pasadena, Calif. "NOAA and other weather agencies will use the data to predict global and regional weather patterns. The information from SeaWinds can also be used in a broad variety of applications, including daily maps of sea ice extent around Earth's poles, measuring soil moisture content and snow cover, and regional flood detection. Other applications include ship routing and production of oil and food."

SeaWinds on Adeos 2 will map wind speed and direction across 90 percent of the Earth's ice-free oceans every two days. Up to 15 times a day, Adeos 2 will beam down SeaWinds-collected science data to ground stations operated by NASA and the National Space Development Agency of Japan, which then relay them to scientists and weather forecasters. SeaWinds will provide ocean wind coverage to an international team of climate specialists, oceanographers and meteorologists interested in discovering secrets of climate patterns and improving the speed with which emergency preparedness agencies can respond to fast-moving weather fronts, floods, hurricanes, tsunamis and other natural disasters.

Scatterometers operate by transmitting high-frequency microwave pulses to the ocean surface and measuring the "backscattered," or echoed, radar pulses bounced back to the satellite. The instrument senses ripples caused by winds near the ocean's surface, from which scientists can compute the winds' speed and direction. These instruments can acquire hundreds of times more observations of surface wind velocity each day than can ships and buoys, and are the only remote-sensing systems able to provide continuous, accurate and high-resolution measurements of both wind speeds and direction under most weather conditions. As such, scatterometers such as SeaWinds play an increasingly important role in oceanographic, meteorological and climate studies.

As part of NASA's Earth Observing System, designed to address global environmental changes, SeaWinds data will be combined with information on ocean surface height (topography) from two other ocean-observing satellites--the joint NASA-French Topex/Poseidon and Jason missions--to obtain a more complete, near-real-time look at wind patterns and their effects on ocean waves and currents. The data also will complement data being collected by other NASA Earth-monitoring satellites such as the Tropical Rain Measurement Mission, Terra, Aqua and SeaWiFS. SeaWinds also will have strong science synergies with the Japanese Space Agency's Advanced Microwave Scanning Radiometer sensor onboard Adeos 2, improving SeaWinds' data in light rain conditions and providing accurate flagging for heavy rain conditions.

The 200-kilogram (441-pound) SeaWinds instrument will be launched aboard the Adeos 2 satellite by a Japanese H-IIA rocket and placed into a near-circular, sun-synchronous, near-polar orbit inclined 98.6 degrees to the equator. The satellite will circle Earth every 101 minutes at an altitude of 803 kilometers (499 miles). The SeaWinds instrument will make approximately 400,000 measurements every day.

The Japanese Space Agency's satellite is designed to acquire data for global climate change research and applications such as meteorology and fishery. The satellite is also equipped with four other sensors from Japan and other partners.

SeaWinds on Adeos 2 is managed for NASA's Office of Earth Science, Washington, by JPL, which developed the instrument and performs instrument operations and science

data processing, archiving and distribution. NASA also provides U.S. ground system support. The Japanese Space Agency provided the Adeos 2 spacecraft, H-IIA launch vehicle, mission operations and the Japanese ground network. NOAA provides near-real-time data processing and distribution for SeaWinds operational data users.

# Media Services Information

## **NASA Television Transmission**

NASA Television is broadcast on satellite GE-2, transponder 9C, C band, 85 degrees west longitude, frequency 3880.0 MHz, vertical polarization, audio monaural at 6.8 MHz. The tentative schedule for television transmissions for SeaWinds activities is described below; updates will be available from the Jet Propulsion Laboratory, Pasadena, Calif.; NASA Headquarters, Washington; and also on the Internet at <http://www.nasa.gov/ntv> .

## **Briefings and Television Feed**

An overview of the SeaWinds mission will be presented in a news briefing broadcast on NASA Television originating from NASA Headquarters at Noon EST on November 26, 2002.

Prelaunch news conferences will be conducted two days and one day prior to launch by the National Space Development Agency of Japan at Japan's Tanegashima Space Center.

The launch will not be broadcast live on NASA Television, but will be accessible via a live webcast originating from the National Space Development Agency of Japan at <http://www.jpl.nasa.gov/webcast/seawinds> .

The webcast will begin one hour prior to launch and end approximately one hour after launch. It will be conducted in Japanese, with English translation provided during the last few minutes before launch until shortly after launch. The launch will be rebroadcast on NASA Television as soon as the broadcast tape is received in the United States. The National Space Development Agency of Japan plans to conduct two post launch news conferences from Tanegashima on the day of launch.

## **Status Reports**

The NASA Jet Propulsion Laboratory Media Relations Office will issue status reports on SeaWinds-related mission activities. They may be accessed online as noted below. The Japanese Space Agency is responsible for issuing status reports on overall Adeos 2 mission activities.

## **Launch Media Credentialing**

News media representatives who wish to cover the launch in person must be accredited through the National Space Development Agency of Japan's Public Relations Office



in Tokyo, Japan. For information on launch accreditation, contact Takayuki Kawai at 81-3-3438-6107, 6108 or 6109.

### **Internet Information**

Information on SeaWinds on Adeos 2, including an electronic copy of this press kit, press releases, fact sheets, status reports and images, is available from a variety of sources.

The Jet Propulsion Laboratory's home page is at:

**<http://www.jpl.nasa.gov>**

The SeaWinds on Adeos 2 home page is at:

**<http://winds.jpl.nasa.gov/missions/SeaWinds/seaindex.html>**

Information about NASA's scatterometer experiments is at:

**<http://winds.jpl.nasa.gov>**

The National Space Development Agency of Japan's home page is at:

**[http://yyy.tksc.nasda.go.jp/index\\_e.html](http://yyy.tksc.nasda.go.jp/index_e.html)**

NOAA's home page is at:

**<http://www.noaa.gov>**

The home page for NASA's Office of Earth Science is at:

**<http://www.earth.nasa.gov>**

# Quick Facts

## **Advanced Earth Observing Satellite II**

Dimensions: Spacecraft about 6 meters (19.7 feet) by 4 meters (13.1 feet) by 4 meters (13.1 feet); solar array about 3 meters (9.8 feet) by 24 meters (78.7 feet)

Weight: 3,680 kilograms (8,113 pounds)

Power: Solar array paddle providing 5,350 watts (end of life) at 33.5 to 53 volts

Science instruments: Advanced Microwave Scanning Radiometer (Japanese Space Agency); Global Imager (Japanese Space Agency); Improved Limb Atmospheric Spectrometer II (Ministry of Environment Japan); SeaWinds (NASA); Polarization and Directionality of the Earth's Reflectances (Centre National d'Etudes Spatiales)

Other Mission Instruments: Data Collecting System (Japanese Space Agency/CNES); Technical Data Acquisition Equipment (Japanese Space Agency)

## **SeaWinds Instrument**

Radar: 110-watt pulse at frequency of 13.4 gigahertz, transmitted and received by 1-meter-diameter (39-inch) antenna rotating at 18 revolutions per minute

Weight: 200 kilograms (440 pounds)

Power consumption: 220 watts

Maximum science data rate: 40 kilobits per second

Coverage: 1,800-kilometer (1,120-mile) swath during each orbit, covering about 90 percent of Earth's ice-free oceans every day

Measurements: Wind speeds between 3 and 30 meters per second (7 and 67 miles per hour), accurate to about 2 meters per second (4.5 miles per hour); wind direction accurate to 20 degrees; wind-vector measurement resolution of 25 kilometers (15.5 miles)

## **Launch Vehicle**

Type: H-IIA

## **Mission**

Launch: December 14, 2002 Japan Standard Time (December 13, 2002 in U.S. time zones) from H-IIA Launch Complex, Tanegashima Space Center, Japan

Daily launch opportunity: 16-minute window for December 14 opens at 10:31 a.m. Japan Standard Time (5:31 p.m. Pacific Standard Time on December 13); window varies on other days

Launch period: Pad reserved until December 30, 2002

Primary mission: Three years (five-year design goal)

Orbit path: Circular 803-kilometer-altitude (499-mile) crossing close to Earth's north and south poles at inclination of 98.6 degrees; one orbit every 101 minutes

## **Program**

Cost: SeaWinds total cost of \$154 million (\$138 million for development; \$16 million for five years of operations); additional NASA ground network costs of \$11 million, which support overall Adeos 2 mission. NOAA is contributing \$14 million for the NASA ground network support to the overall Adeos 2 mission.

# Why Study Ocean Winds?

The SeaWinds scatterometer instrument on ADEOS 2 will help us expand our knowledge and understanding of ocean circulation, wind speed and wind directional patterns.

Current knowledge of ocean surface winds is uncertain, coming mostly from localized, infrequent and often inaccurate reports from ships. Earth-orbiting radar instruments called scatterometers are the only remote-sensing instruments capable of measuring wind speed and direction across the globe under most weather conditions. These instruments emit radar pulses that are reflected, or "backscattered," by rippling wave patterns on ocean surfaces. Automatic analysis of the reflected signal can reveal the speed and direction of the winds that created the ocean rippling.

The SeaWinds radar instrument will map wind speed and direction across 90 percent of the Earth's ice-free oceans each day, assembling a picture of the entire globe once every two days and providing data to operational users in less than three hours. By combining wind data from SeaWinds with wind data from the orbiting Quikscat satellite and with ocean height data from the joint NASA-French Jason and Topex/Poseidon satellites, Earth scientists will be able to obtain a more complete, near real-time look at wind patterns and their effects on ocean waves and currents.

## How Scatterometers Work

Scatterometry has its roots in early radar equipment used in World War II. In the 1950s and 1960s, radar operators on naval and merchant ships experienced a troublesome phenomenon called "sea clutter." Appearing on radar screens as noise that obscured small boats or low-flying aircraft, this clutter was, in fact, radar pulses returned from the ocean surface. Radar reflection, or backscattering, was caused by the interaction of the radar signal with wind-blown, rippling waves, also called "cat's paws," on the ocean's surface, each about 1 to 3 centimeters (1/2 to 1-1/2 inches) in height. While electronics were developed to reduce this interference in conventional radar, researchers realized that radar instruments could be customized to take advantage of this backscattering.

In the 1960s, scientists established a link between such ocean waves and the speed of wind just above the ocean's surface. By sending radar pulses from an airborne or spaceborne instrument and then measuring the backscattered signal, they could indirectly gauge ocean wind speed. In addition to measuring radar backscatter, they also learned that backscattered signals were influenced by the direction of the wind. By taking into account the angle at which the radar was beaming its pulses down toward the ocean, they could calculate wind direction.

Satellites promised to be far more effective than the prevailing practice of collecting

wind readings from ships. Most ocean ship reports are limited in their geographical coverage, and ships necessarily must stay away from active storm regions. Ship reports of wind velocity are also notoriously inaccurate owing to untrained observers, poor quality instruments, questionable measurements caused by the motion of the vessels and a variety of other conditions. Moored buoys gathering wind data are highly accurate, but such buoys are few in number and concentrated in coastal regions in the northern hemisphere.

Only satellite-borne instruments can acquire wind data with global coverage, high spatial resolution and frequent sampling. Certain satellite instruments called altimeters and radiometers can be used to estimate wind speeds. However, these instruments do not measure wind direction, thus making them less useful to scientists who are trying to understand atmospheric dynamics.

Orbiting scatterometers can acquire hundreds of times more observations of surface wind velocity each day than can ships and buoys. These orbiting instruments also are the only proven remote-sensing systems able to provide accurate, frequent, high-resolution measurements of ocean surface wind speed and direction in both clear sky and cloudy conditions.

To accurately determine wind speed and direction over each ocean location, scatterometers quickly measure backscatter from each location from different viewpoints. To provide near daily global coverage, the instrument must make these multiple individual measurements over a wide swath of sea surface near simultaneously as the satellite moves over the ocean. The instrument design, using a spinning antenna with multiple beams, enables the instrument to satisfy these diverse requirements in a compact package that can be more easily accommodated on spacecraft with limited payload space.

## **History of Scatterometers**

Scatterometers have been flown on space missions since the early 1970s. In addition to such experiments on satellites and crewed flights, they have also been tested in flights on airplanes.

**Skylab:** The first scatterometer in space flew as part of the crewed Skylab missions in 1973 and 1974, and demonstrated that spaceborne scatterometers were feasible. The Skylab missions carried a relatively simple radar instrument, however, that could make only single measurements of wind speeds at one location on the sea surface at any given time. In order to calculate wind speed, wind direction had to be obtained from some other source.

**SeaSat:** In 1978, a scatterometer was flown on NASA's SeaSat satellite, which tested a number of different spaceborne oceanographic instruments. This instrument used a total of four fan-beamed antennas to allow it to take readings from a pair of swaths

instead of a single point. It was capable of spatial resolution of approximately 50 kilometers (30 miles) in two swaths about 600 kilometers (370 miles) wide.

Measurements from the various antennas were combined to provide estimates of wind speed and up to four possible directions. Due to a spacecraft malfunction, the SeaSat mission lasted only four months, from June to October 1978. Despite the brevity of the mission, the scatterometer on SeaSat achieved a number of major technical milestones and returned a wealth of scientific information.

**European Remote Sensing Satellites:** These satellites, the European Remote Sensing Satellite 1, launched in July 1991 and retired after nine years of service in March 2000; and European Remote Sensing Satellite 2, launched in April 1995, carry radar instruments with split personalities, functioning both as imaging radar to take pictures of land masses and as scatterometers to study ocean winds. In their scatterometer mode, the satellites' instruments take readings across a 500-kilometer- (310-mile) wide swath on the starboard side of the spacecraft, sending and receiving radar pulses in the microwave C-band at a frequency near 5 gigahertz. The spacecraft coverage is limited by their single-swath design and the narrow width of their swath. The European Remote Sensing Satellite 1 provided the longest record of global scatterometer data yet obtained.

**NASA Scatterometer:** The NASA Scatterometer was launched in August 1996 by the Japanese Space Agency onboard its Midori satellite. Named with the Japanese word for "greenery," the satellite was also known as the Advanced Earth Observing Satellite.

The NASA Scatterometer was designed to take 190,000 wind measurements per day, mapping more than 90 percent of the world's ice-free oceans every two days. During its lifetime the instrument provided scientists with more than 100 times the amount of ocean wind information available from ship observations and buoys. The instrument's operation ended in June 1997 when the Adeos spacecraft malfunctioned.

**Quikscat:** NASA's Quick Scatterometer, or QuikScat, was built in record time, or "quickly," in just 12 months to replace the loss of the NASA Scatterometer. QuikScat carried the first SeaWinds scatterometer instrument and was launched in June 1999 aboard a Titan II launch vehicle and is still in operational service, operating longer than any previous Ku-band scatterometer. It circles Earth at an altitude of 800 kilometers (500 miles) once every 101 minutes, passing close to Earth's north and south poles. The scatterometer instrument it carries is the same SeaWinds design that will fly aboard Adeos 2.

Quikscat has provided consistent, reliable data that is being widely used for both scientific and operational purposes. Its data have become a high-priority data set for weather forecasters, and are a significant resource in a large number of weather advisories issued today. In January 2002, the United States and Europe incorporated wind speed and direction data from Quikscat into their operational global weather analysis and forecast systems.

Current routine users of Quikscat's vector wind, ice and radar backscatter data include NASA investigators, NOAA, the National Weather Service, the Air Force Weather Agency, the Navy Joint Typhoon Warning Center, the Japan Meteorological Agency, the European Centre for Medium-Range Weather Forecasting, Meteo-France, the Hong Kong Observatory, the Meteorological Service of Canada/Environment Canada, the Australian Bureau of Meteorology, the Royal Netherlands Meteorological Institute, the Norwegian Meteorological Institute, the Korean Meteorological Administration, Lawrence Livermore Laboratory and the U.S. Department of Defense's Fleet Numerical Meteorological and Oceanography Center.

## **Benefits**

SeaWinds on Adeos 2 data will provide benefits in areas ranging from weather forecasting to help for various industries that rely on the sea.

Weather forecasting. Nearly two-thirds of Earth is covered by oceans, where there are no weather stations and only a scattered array of buoys. This lack of information hampers scientists' knowledge of today's weather and impedes their ability to forecast the future. Most of the weather that hits the coastal areas of the United States begins over the oceans. SeaWinds frequent, extensive and all-weather coverage will alleviate this problem.

NOAA will process SeaWinds data in near real time and distribute it to NOAA's National Weather Service and other users who will incorporate the measurements into their forecast models. The data will be important for short-term weather warnings and forecasts, and will play a key role in scientists' ability to understand and predict complex global weather patterns and climate systems.

SeaWinds also will play an important role in NASA's continuing work to monitor global El Niño and La Niña weather abnormalities. Changes in the winds over the Pacific are a key component of the El Niño/La Niña phenomenon. The instrument will be able to track the changes in the trade winds along the equator when a new El Niño develops and will help predict a La Niña condition that might arise in the wake of an El Niño.

**Storm detection:** SeaWinds radar will be able to determine the location, structure and strength of storms at sea. Severe marine storms - hurricanes in the Atlantic, typhoons near Asia and mid-latitude cyclones worldwide - are among the most destructive of all natural phenomena. In the United States alone, hurricanes have been responsible for well in excess of 16,000 deaths since 1900, and have caused hundreds of millions of dollars in damage annually. If worldwide statistics are considered, the numbers are substantially higher. And while mid-latitude cyclones are not usually as violent as hurricanes and typhoons, these storms also exact a heavy toll in casualties and material damage. The SeaWinds radar's accuracy and broad coverage of surface winds can help to significantly reduce uncertainties in predicting the landfall of hurri-

canes, minimizing economic disruption and reducing the scope of evacuations. NOAA has estimated that reducing the length of coastline under hurricane warnings saves between \$600,000 and \$1 million per coastal mile in the costs of evacuations and other preparedness actions.

In recent years, scientists' ability to detect and track severe storms has been dramatically enhanced by the advent of weather satellites. Cloud images from space are now routine on TV weather reports. SeaWinds will augment these familiar images by providing a direct measurement of surface winds to compare to observed cloud patterns. These wind measurements can help to identify more accurately the extent of gale force winds associated with a storm, and will provide inputs to computer models that provide advance warnings of high waves and flooding.

**Global climate:** Another important application of SeaWinds data is for studies of world climate and global warming. Most of the heat absorbed by Earth is stored in the tropics near the equator. The main factor responsible for world climate is heat transport from the tropics to higher latitudes. This heat transport takes place through the process of ocean circulation -- and the winds that drive the ocean. Precise knowledge of the winds over the global ocean will enable scientists to better understand this complicated process.

**Monsoon monitoring:** Monsoons are heavy winds and rain in the tropics that result from seasonal changes in winds caused by differences in temperatures over land and water. Monsoons affect large areas of the world, but are most common in the Indian Ocean and Southeast Asia. Their annual onset, intensity and retreat vary greatly, and the variation of a monsoon has strong economic impact and the potential for widespread human suffering. Besides bringing rain to land, a monsoon also changes ocean currents, and stirs nutrients in the depths of the ocean that sustain great populations of fish and other sea life. SeaWinds, with its repeated global observations and unprecedented spatial resolution, will help scientists monitor and understand the development, movement and potential strength of these seasonal weather systems.

**Polar ice and land vegetation monitoring:** SeaWinds Ku-band backscatter data will be used to generate daily sea-ice maps at 6-kilometer (3.7-mile) resolution. Such data can be used to monitor seasonal ice changes. Scatterometer data have already been used to track the breakup of giant icebergs. In 1992 a giant iceberg nearly the size of Rhode Island, known as B10A, broke away from the Thwaites glacier in Antarctica. The iceberg was observed by NSCAT in September 1996, floating in the Antarctic ice pack. By 1999, conventional methods of tracking icebergs lost sight of the iceberg's location due to poor visibility and cloudy Antarctic winters. However, B10A was spotted again by the SeaWinds scatterometer on Quikscat in July 1999 during its first pass over Antarctica. The iceberg was breaking up and being driven by ocean currents and winds into the shipping lane, where it posed a threat to commercial, cruise and fishing ships.

Wind speeds and direction influence the climate and vegetation of Earth's rain forests. Data from SeaWinds will augment information from the currently orbiting Tropical Rainfall Measuring Mission, a joint U.S.-Japanese satellite that monitors rain over the tropics, to help scientists better determine changes that might be occurring in the types of vegetation found in rain forests.

**Food production:** Perhaps the oldest use of the ocean is in the harvesting of food. Today, ocean fishing is a highly systematic activity that makes extensive use of advanced technology to reduce the cost and to increase the value of every "catch." Detailed wind data from scatterometers can aid in the management of commercial seafood crops.



# Mission Overview

NASA's SeaWinds scatterometer instrument on Japan's Advanced Earth Observing Satellite 2 is a microwave radar that measures surface wind speed and direction over the ice-free global oceans every day. A joint mission with the National Space Development Agency of Japan and NOAA, SeaWinds will continue the systematic measurements that began with the NASA Scatterometer aboard Japan's Adeos spacecraft in 1996 and have been continued over the past 3-1/2 years by NASA's Quick Scatterometer mission. The SeaWinds measurements can also contribute to other applications, including sea ice extent monitoring, flood detection, soil moisture and vegetation studies.

SeaWinds on Adeos 2 will be launched on a Japanese H-IIA launch vehicle from the National Space Development Agency of Japan's H-IIA Launch Complex at the Tanegashima Space Center, Minamitane-cho, Kumage-gun, Kagoshima, Japan, entering a north-south orbit. Its primary mission is scheduled to continue for three years

## Launch Site

The Tanegashima Space Center is the Japanese Space Agency's largest facility. Located on Tanegashima Island, 115 kilometers (71.5 miles) south of Kyushu, this vast 8.6 million square meter (3.3 square mile) complex plays a central role in pre-launch countdown and post-launch tracking operations. On-site facilities include the Takesaki Range (for small rockets), the Osaki Range (for J-I and H-IIA launch vehicles), the Masuda Tracking and Communication Station, the Nogi Radar Station, the Uchugaoka Radar Station and optical observation facilities to the west. There also are related developmental facilities for firing of liquid- and solid-fuel rocket engines.

## Launch Vehicle

The H-IIA is a two-stage Japanese launch vehicle that can launch up to a five-ton class satellite into a geostationary transfer orbit. About the same size as a 17-story building, the main body of the H-IIA is an approximately 53-meter-tall (174-foot) cylinder with a diameter of four meters (13.1 feet). The payload fairing attached to the top of the H-IIA adjusts to accommodate the size of individual payloads, allowing the rocket's precise height to vary. The first stage is 37.2 meters (122 feet) tall, including the interstage that covers the lower half of the second stage. The second stage is 10.7 meters (35.1 feet) long on the top of the first stage. The payload fairing at the top is approximately 12 meters (39.4 feet) high and 5 meters (16.4 feet) in diameter.

The first stage LE-7A engine uses liquid oxygen and liquid hydrogen as propellants, producing 1,074,000 Newtons (241,445 pounds) of thrust in a vacuum. Two solid-propellant rocket boosters using a hydroxyl terminated polybutadiene composite propellant are attached to the first stage; each is 2.5 meters in diameter and 15.2 meters high

and produces 4,520,000 Newtons (1,016,136 pounds) of thrust in a vacuum. The second stage engine uses liquid oxygen and liquid hydrogen as propellants, producing 137,000 Newtons (30,799 pounds) of thrust in a vacuum.

## **Launch Timing**

Unlike spacecraft sent to other planets, comets or asteroids, the launches of Earth-orbiting satellites such as Adeos 2 do not need to be timed based on the alignment of the planets. The launch date is based only on the readiness of the satellites, the H-IIA launch vehicle and the launch range at Tanegashima Space Center.

Earth-orbiting satellites do, however, need to be launched during particular windows within any given 24-hour day in order to get into the proper orbit around Earth. Adeos 2 will assume what is called a "Sun-synchronous" orbit flying close to Earth's north and south poles. In order to achieve this orbit, the satellite must be launched during a daily 16-minute launch window that varies throughout the launch period. Launch is currently scheduled for December 14, 2002 Japan Standard Time.

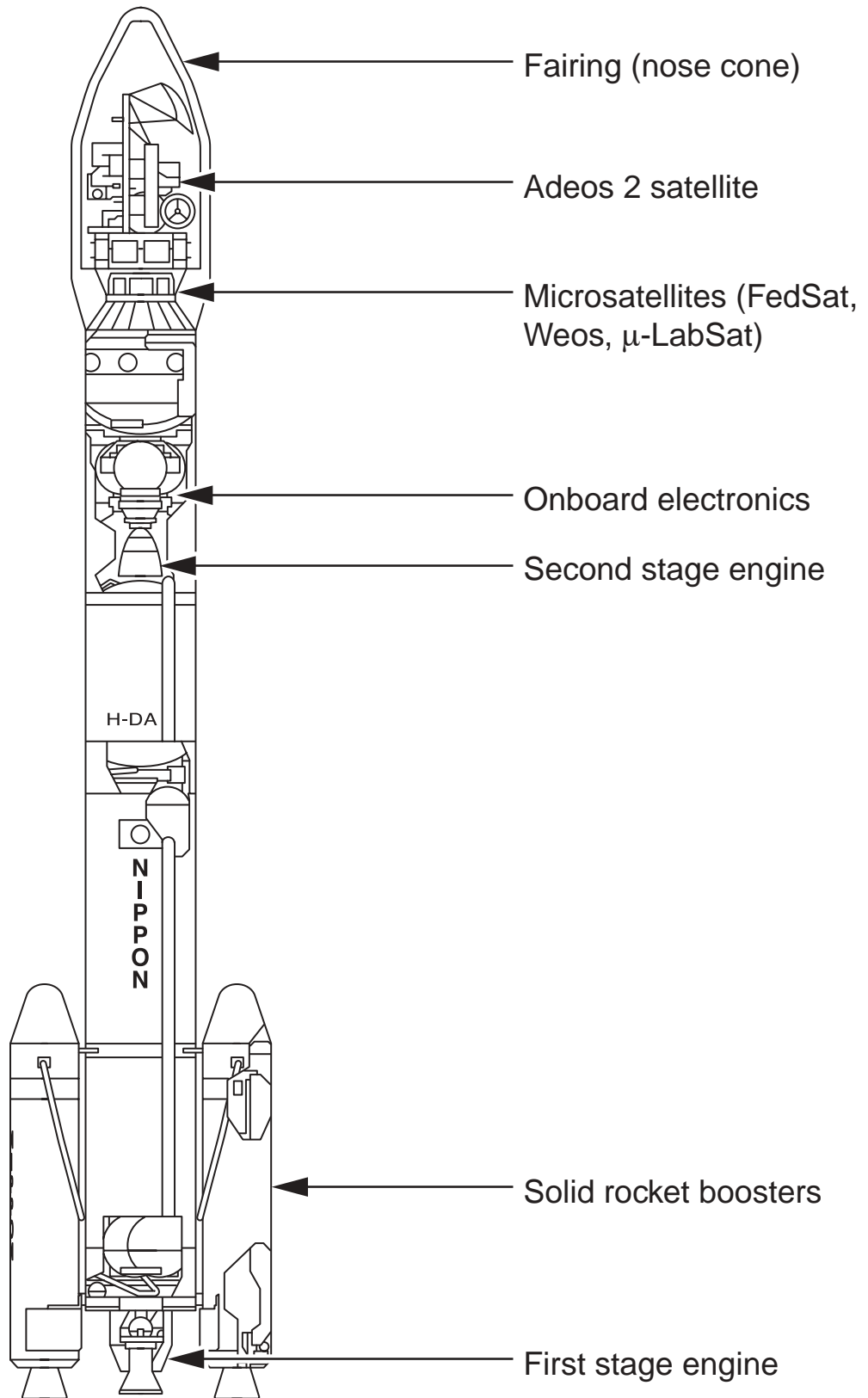
## **Launch Events**

Liftoff takes place when the H-IIA's first stage engine ignites and the rocket rises vertically from the launch pad and then heads south over the Pacific Ocean.

About one minute and 47 seconds after lift-off, the twin solid rocket boosters will separate from the H-IIA vehicle. At approximately 4 minutes, 20 seconds into the mission the H-IIA's fairing or nose cone splits in half like a clamshell and is jettisoned. At six minutes, 35 seconds into the flight, the first stage engine shuts down and within seconds it is separated from the second stage. Six seconds after separation, the second stage engine ignites, burning until 15 minutes, 38 seconds into the flight when it shuts down. At approximately 16 minutes, 28 seconds into the flight, over the area between the Philippines and Indonesia, the Adeos 2 spacecraft will separate from the second stage. The rocket's three other piggyback satellites will subsequently separate from the second stage over the next 18 minutes. At approximately 12-1/2 hours into the mission, SeaWinds' V-band antenna will be unlocked.

After separation, Adeos 2 will deploy its solar array and point its mission instruments, including SeaWinds, at Earth using three-axis attitude control. The satellite will then be commanded by a ground station to deploy its inter-orbital communications subsystem antenna. All sensors and units will be checked and Adeos 2 will be maneuvered into its circular, sun-synchronous orbit about 800 kilometers (500 miles) above Earth.

Twenty-seven days after launch, the SeaWinds instrument will be turned on for the first time and placed in a receive-only mode. In this mode most of its systems will be operating but the instrument will only be receiving and not transmitting. Then, at 44 days after launch, the instrument is transitioned to winds observation mode-the instrument's



*H-IIA launch vehicle*

normal science mode--allowing it to both send and receive signals. Over the next four days, members of the science team will thoroughly check out the instrument. At 120 days after launch, the instrument will begin a six-month calibration/validation phase, during which time it will be configured and checked out for science observations. Nominal science operations will then begin at 10 months after launch. The primary mission is scheduled to continue for three years, with a mission life goal of five years.

## **Satellite Operations**

Adeos 2 spacecraft operations will be handled by the National Space Development Agency of Japan. Staff at the agency will plan and schedule satellite operations; monitor and control the satellite; determine the satellite's orbit; and analyze many megabytes of engineering data on the health and status of the satellite.

The network of ground stations communicating with the satellite is comprised of Japanese and NASA ground network stations. The NASA stations only receive mission science data and do not perform command functions. NASA's ground network stations are located at NASA's Wallops Flight Facility, Wallops Island, Va.; and the Alaska Synthetic Aperture Radar Facility in Fairbanks, Alaska. The station at Wallops Island uses a dish antenna 11.3 meters (37 feet) in diameter; the Alaska Synthetic Aperture Radar Facility is equipped with dual dish antennas 10 meters (33 feet) and 11.5 meters (37.7 feet) in diameter. Flight system commanding and engineering analysis will be performed by the Japanese Space Agency's Tracking and Control Center in Tsukuba City. Mission data archive and distribution will be performed at the Japanese Space Agency's Hatoyama Earth Observation Center facility. A third ground station in Kiruna, Sweden, will also be used.

Data will be transferred between Japan and the United States by a transpacific cable jointly maintained by NASA and the Japanese Space Agency.

Up to 15 times a day, SeaWinds will send science data to ground stations. For routine operations, the satellite will communicate with a given ground station for 8 to 10 minutes at a time.

Science data from SeaWinds on Adeos 2 will be received and recorded by the Japanese Space Agency's Earth Observation Center, NASA's ground stations and Sweden's Kiruna station. NOAA will process data at a facility in Suitland, Md., forwarding them to meteorological agencies around the world and to the general public. In addition, data will be processed by the SeaWinds Project at JPL and then sent to NASA's Physical Oceanography Distributed Active Archive Center for archiving and distribution. JPL will present the science data on a web page at <http://winds.jpl.nasa.gov> .

Operational data products will be distributed by NOAA for international meteorological agencies and operational communities within three hours of data collection.

# The SeaWinds Instrument

The SeaWinds instrument on Adeos 2 will study ocean winds by transmitting radar pulses toward Earth. Pulses are reflected, or "backscattered," from the ocean's surface and received back on the satellite. Automated analysis of the reflected signal provides a signature of ripples on the ocean's surface, which, in turn, reveals the speed and direction of winds that create them.

The orbit of Adeos 2 will allow the radar instrument to view 90 percent of the world's ice-free ocean surface, assembling a complete map of the world's oceans every two days. On each 101-minute orbit, the instrument will collect and forward 282 megabits of science data. The accuracy of the wind speed measurements is better than 2 meters per second (4.5 miles per hour) for wind speeds from about 3 to 20 meters per second (7 to 45 miles per hour), and within 10 percent for winds from about 20 to 30 meters per second (45 to 70 miles per hour). Wind direction is accurate to within 20 degrees.

The compact, lightweight instrument is of the same design as the SeaWinds instrument currently flying on NASA's Quikscat spacecraft. The primary instrument differences with Quikscat are the spacecraft command and telemetry interface and thermal control features. SeaWinds ground data processing software will also use data from the National Space Development Agency of Japan's Advanced Microwave Scanning Radiometer to indicate the presence of rain in SeaWinds measurements and to enhance SeaWinds accuracy by enabling correction for atmospheric moisture and light rain.

The instrument consists of a radio transmitter and receiver, rotating dish antenna, instrument controller and data handler and power converters. It switches back and forth between transmitting and receiving pulses some 200 times per second. It has three main subsystems: radar electronics, antenna, and command and data.

The radar electronics subsystem generates, shapes and amplifies the transmitted microwave signal required by SeaWinds and receives and processes the reflected echo from the Earth's surface. The subsystem also includes switching to select the appropriate antenna beam for each pulse and to protect the receiver while transmitting. A precision internal calibration loop detects the small performance changes caused by orbital temperature variations so they may be compensated for during ground data processing. The radar provides Doppler compensation and range compression processing.

The antenna subsystem provides the required radar illumination of the Earth's surface to enable SeaWinds to achieve 25-kilometer (15.5-mile) measurement resolution. The antenna subsystem includes a one-meter (3.2-foot), continuously spinning reflector antenna that provides two independent radio frequency beams with look angles of 40

and 46 degrees relative to nadir. As the antenna rotates, the two beams sweep out a circular pattern on the Earth's surface that enable SeaWinds to acquire multiple backscatter measurements from different viewpoints as the satellite moves overhead. The subsystem includes a motor and control electronics to maintain a stable rotation rate of 18 revolutions per minute, allowing it to observe an 1,800-kilometer (1,120-mile) wide swath passing underneath on Earth. The subsystem includes a V-band clamp to lock the antenna during launch; the V-band is released by the spacecraft about 12-1/2 hours after launch.

The command and data subsystem controls the overall operation of the SeaWinds instrument and provides most electrical interfaces between SeaWinds and Adeos 2. The subsystem receives and formats the processed radar echo from the radar electronics and engineering telemetry from all three subsystems (e.g., temperatures and operating voltages and currents) and supplies SeaWinds data to the spacecraft, which then transmits the data to ground stations. The subsystem includes fault protection to place the instrument into a "safe" state if engineering telemetry exceeds expected ranges. The subsystem also receives and processes commands.

All instrument electronics are redundant.

SeaWinds instrument operations and data processing are conducted by JPL. For normal instrument operation, few ground commands are necessary. When commanding is needed, JPL sends the required command instruments to the Japanese Space Agency which, in turn, transmits the command to Adeos 2 to relay to SeaWinds. JPL automatically receives SeaWinds data from NASA and Japanese Space Agency ground stations and processes this data to produce the wind vector measurements.

# Adeos 2 Satellite

The Adeos 2 satellite is the largest satellite ever developed by Japan. The satellite's main structure, or bus, measures 6 by 4 by 4 meters (19.7 by 13.1 by 13.1 feet). Dimensions of the solar array paddle are 3 by 24 meters (9.8 by 78.7 feet). When the solar array paddle is fully deployed, its wingspan is 11 meters (26 feet) in the flight direction and 29 meters (95 feet) in the perpendicular direction.

The spacecraft consists of a mission module that carries mission instruments and a bus module that carries engineering subsystems. Most of the observation instruments are installed on the Earth-viewing side of the mission module. The scanning radiometer, inter-orbital communication subsystem and the solar array paddle are installed on the space-viewing side of the mission module. The communications and data handling subsystem, mission data processing subsystem, direct transmission subsystem, electrical power subsystem, attitude and orbit control subsystem and reaction control subsystem units are located on the bus module.

The satellite has a launch mass of approximately 3,680 kilograms (8,113 pounds) and an in-orbit power generation capability of approximately 5,350 watts. The communications and data handling subsystem has an onboard computer that allows for automatic, autonomous operation of the mission instruments by storing weekly mission operation plans as well as for checking the status of the mission instruments. The inter-orbital communications subsystem transmits observation data via the Data Relay Test Satellite. The reaction control subsystem generates the thrust necessary for orbital maneuvers using one-Newton and 20-Newton thrusters.

Most subsystems on the satellite are redundant, so if one fails a backup unit can take over. The satellite is designed to survive for three years, with a goal life of five years.

## **Communications and Data Handling Subsystem**

This subsystem receives and decodes commands from the tracking and control station and distributes them to the instruments. It also collects and edits housekeeping telemetry such as temperature, voltage, status, etc., and transmits it to the ground stations on a 2-gigahertz band.

## **Inter-Orbital Communication Subsystem**

This subsystem performs inter-satellite communication at S-band and Ka-band using data-relay satellites such as the Data Relay Test Satellite. It consists of S- and Ka-band transmitters, an S-band receiver, a tracking receiver, an antenna pointing motor and an S- and Ka-band dual antenna all in one box.

## **Mission Data Processing Subsystem**

This subsystem selects the mission data to be transmitted, adds information to be used in ground data processing, multiplexes and packetizes it, and transmits it to the satellite's direct transmission subsystem and/or the inter-orbital communication subsystem. The subsystem has three mission data recorders that record data at 6 megabytes per second and reproduce the data at 60 megabytes per second.

### **Direct Transmission Subsystem**

This subsystem transmits data observed by the satellite to the ground stations. The medium- and high-speed mission data are transmitted at X band (60 megabytes per second and 6 megabytes per second data).

### **Electrical Power Subsystem**

This supplies electrical power to every subsystem on the satellite, charges and discharges the batteries and controls ordnance power. The subsystem relies on battery power during eclipses. During sunshine, electrical power generated by the solar paddle is stabilized by the power control unit. Power is also used to charge the battery. Excess power is dissipated by digital sequential shunts. The subsystem also supplies ordnance power via the ordnance controller to the electro explosive devices of each deployment mechanism on the solar array paddle, the data collecting system antennas, the inter-orbital communication subsystem compartment and for uncaging the scanning radiometer and SeaWinds instruments.

### **Solar Array Paddle Subsystem**

This subsystem transforms solar power into electric power. The lightweight, high-power (more than 5,350 watts at end of life) subsystem features an extendable mast covered by 50 flexible blankets containing 55,680 solar cells. The mast measures 24 meters (78.7 feet) in length when fully extended in orbit.

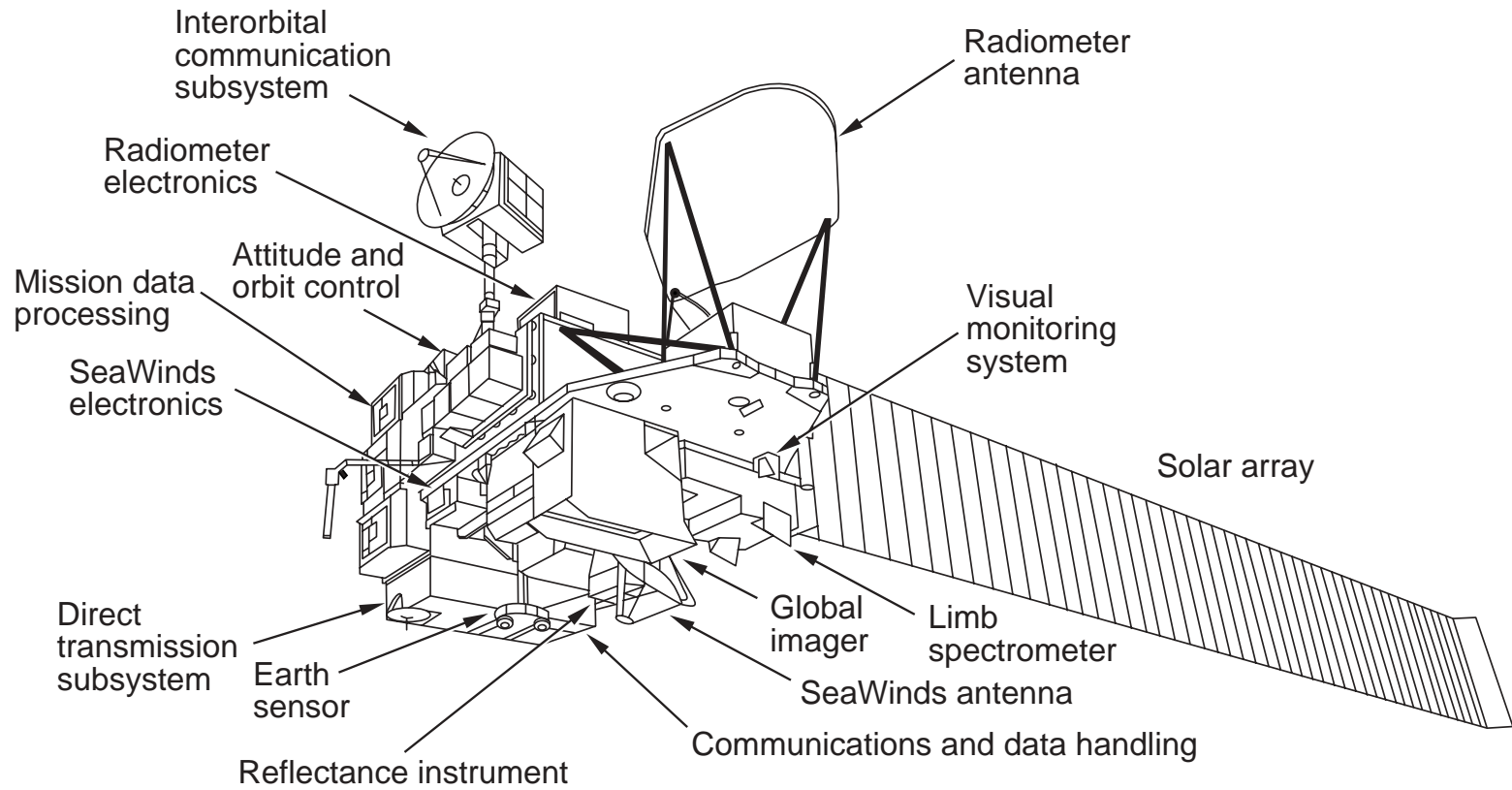
### **Attitude and Orbit Control Subsystem**

This subsystem acquires initial three-axis attitude after orbit injection, maintains the satellite in a stable attitude, controls the sequence of orbit maneuvers and sends drive signals to the Solar Array Paddle. The subsystem includes an inertial reference unit, Earth sensor assembly, fine Sun sensor assembly and a Global Positioning System receiver for accurate attitude determination and attitude control. It also sends drive signals to the reaction wheel assembly, magnetic torques and thrusters.

### **Direct Transmission for Local Users**

This subsystem transmits Global Imager coarse data (spatial resolution of about 6 by 6 kilometers (3.7 by 3.7 miles) for local users such as fishing boats, etc., in the ultra-high





frequency band (467.7 megahertz biphase shift keying, data rate 23 kilobits per second). Data consists of four bands (three visible bands and one infrared band) out of the 36 Global Imager bands. Its data is used to determine ocean conditions, temperature distribution and primary products. An ultra-high frequency transmitter is installed in the mission module and does not have independent thermal control. An ultra-high frequency antenna is located on the Earth-facing panel.

### **Reaction Control Subsystem**

This subsystem generates the thrust necessary for the initial attitude acquisition and orbital maneuvers using one-Newton and 20-Newton thrusters under the attitude and orbit control subsystem control. All components -- thrusters, fuse tanks, valves and pipes -- are integrated into one unit. The unit has independent thermal control.

### **Visual Monitoring System**

This system is a charge-coupled device camera system that monitors and verifies the deployment and the nominal movement of newly developed elements on Adeos 2. It is able to perform snapshot and continuous viewing and to replay by ground commanding. In the initial launch phase it will be used to monitor solar array paddle deployment as well as deployment of the inter-orbital communication subsystem antenna and scanning radiometer.

### **Dynamics Monitoring System**

This is an experimental system that monitors the satellite's onboard behavior. It consists of five accelerometers located on the paddle, three accelerometers located on the spacecraft structure and a star tracker. Accelerometers monitor vibration of the spacecraft structure while the star tracker acquires attitude determination data using star observations as reference points in an inertial coordinate system during normal operation.

# Science Objectives

A team of NASA-funded scientists will work with the SeaWinds on Adeos 2 data. The team's broad objectives are to conduct scientific research exploiting spaceborne vector wind measurements, develop scientifically useful new products from satellite wind instruments, calibrate and validate geophysical data from NASA scatterometers, and evaluate the scientific potential and capability of new measurement techniques. To structure their investigations, the team developed a list of five science objectives:

- ❑ Acquire all-weather, high-resolution measurements of near-surface winds over global oceans. Wind is the single largest source of momentum to the upper ocean, and winds drive oceanic motions on scales ranging from surface waves to basin-wide current systems. They also alter flows of heat, moisture, gases and particles such as dust, thus regulating global and regional climate. An orbiting radar satellite will be able to obtain global coverage of the ways in which winds interact with the ocean surface.
- ❑ Determine atmospheric forcing, ocean response and air-sea interaction mechanisms on various spatial and temporal scales. "Atmospheric forcing" means the exchange of heat and water between the atmosphere and ocean. Driven by winds, this global air-sea engine is responsible for the creation of ocean currents and waves, and regulates the planet's perpetual exchange of energy.
- ❑ Combine wind measurements with other data to identify and understand the mechanisms of global change and weather patterns. SeaWinds on Adeos 2 data will complement information acquired by the currently orbiting Jason-1 and Topex/Poseidon satellites, which use an instrument called an altimeter to measure the height of sea surfaces around the world. Data will also be combined with information from other instruments, such as a color sensor onboard the Sea-viewing, Wide Field-of-View Sensor (SeaWiFS) satellite, which is providing scientists with more information about the types and quantities of marine phytoplankton present in the ocean.
- ❑ Examine seasonal and interannual land vegetation changes. Wind speeds and direction influence the climate and vegetation of Earth's rain forests. SeaWinds on Adeos 2 data will augment information from the currently orbiting Tropical Rainfall Measuring Mission, a joint U.S.-Japanese satellite that monitors rain over the tropics, to help scientists better determine changes that might be occurring in the types of vegetation found in rain forests.
- ❑ Study sea ice-edge movement and polar ice pack changes. SeaWinds data will help scientists examine the climate change of Earth's atmosphere in more depth. An increased understanding of the winds and how they play upon the world's oceans, coupled with information on climate trends such as the sudden "calving," or breakup of huge ice shelves in the Arctic and Antarctic, will improve researchers' ability to predict weather and longer-term climate change.

# Program/Project Management

The SeaWinds on Adeos 2 mission is managed for NASA's Office of Earth Science, Washington, by the Jet Propulsion Laboratory, Pasadena, Calif.

At NASA Headquarters, Dr. Ghassem Asrar is associate administrator for the Office of Earth Science. Dr. Jack Kaye is director of the Office of Earth Science's Research Division, and Dr. William Emery is the program executive for SeaWinds on Adeos 2.

At the Jet Propulsion Laboratory, Moshe Pniel is the scatterometer projects manager and Dr. W. Timothy Liu is the project scientist. Dr. Michael Freilich, Oregon State University, Corvallis, Ore., is the ocean vector science team leader.

The California Institute of Technology, Pasadena, Calif., manages JPL for NASA.